BUILDING ENERGY BENCHMARKING

FINAL TECHNICAL REPORT

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ABSTRACT

This report provides technical information for the State of Iowa public building energy benchmarking pilot project. Participating organizations included fifty-three organizations categorized by five “sectors” - State, County, City, Community Colleges, and K-12 Schools. Forty-nine utility companies were involved in providing energy data for the buildings of these organizations. The methodology used in establishing the human network for participating organizations and utilities, and the process for collecting building energy data are illustrated. Challenges and lessons learned during different stages of this pilot project were analyzed and future process improvements suggested. Three years of monthly energy consumption and cost information for 1,218 public buildings were collected, analyzed, and building energy performance was benchmarked via The Weidt Group’s B3 Benchmarking System software platform. Potential future long-term Iowa benchmarking project benefits, process improvements and project management plan are also recommended.
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EXECUTIVE SUMMARY

Buildings must improve energy efficiency in order to significantly reduce U.S. building energy use, as it accounts for almost 41% of U.S. primary energy use. Building energy benchmarking calculates a building’s Energy Utilization Index or Energy Use Intensity (EUI), and offers an initial building energy performance assessment to inform if an energy auditing process or more detailed analysis may be needed. Benchmarking data is useful for property owners, facilities operators, building designers, and especially the utilities. It facilitates energy accounting, assesses opportunities for improvement, and quantifies and verifies energy savings. The State of Iowa does not have a database for tracking building energy performance. This pilot project was an effort to create an initial energy benchmarking database for 1,218 public buildings, estimated to be approximately 20% of the public building stock, to demonstrate the potential for increasing awareness and informed decision-making. The public building sectors included city, county, K-12, community colleges, and state-owned facilities.

The goals of this pilot project are to:

- Demonstrate an energy benchmarking pilot process state-wide for public facilities, and develop experience on how to engage building owners and best gather building energy data in the state of Iowa;
- Create an initial database of Iowa public buildings for case-study and research on building energy efficiency, and allow the state to assess the current energy usage for public buildings;
- Create a framework for informed decision-making, identify which buildings are good candidates for high Return On Investment (ROI) for energy efficiency improvement projects;
- Provide recommendations for future energy benchmarking process improvements and long term project plan;
- Increase public organizational awareness on building energy usage.

Prior to submitting a grant proposal, a Benchmarking Stakeholder Advisory Group (BSAG) was convened in August 2010 to discuss the process and benefits of benchmarking. The consensus of this group confirmed a pilot benchmarking project would be useful to provide for better and more informed decision-making on energy efficiency evaluations in existing public facilities in Iowa. A Request for Proposal (RFP) was issued by the Iowa State University Purchasing Department listing required and preferred specifications for a building energy benchmarking web-based application. Respondents were evaluated by a sub-committee of the BSAG including the Iowa State University Purchasing Department. The Weidt Group’s web-based B3 Benchmarking system, originally developed for the State of Minnesota, was selected from six respondents based on evaluation criteria including accessibility, user interface, software features, proposed solution, quality and extent of support, reporting capability, security, training provided, and vendor reputation through noted references. The BSAG was convened quarterly for review and comment of project progress from December 2010 – December 2011.

Between November 2010 and March 2011, the project team members became familiar with the system and began connecting with the appropriate public organizations and utilities across the state. This initial period also included updating the B3 system building benchmarks to Iowa climate data and customizing the website for Iowa-specific utility and organization
contacts. Initial state-wide invitations to public organizations for participation in the pilot project began in March 2011 with assistance.

Between April 2011 and February 2012, data was collected from participating organizations and corresponding utility companies and imported into the B3 application. The building energy data collection process included building information and utility account information, meter identifications, third-party authorizations, utility meter data, data import, and data problem investigation. Building information, utility account information, and meter identifications were collected from each organization. Third-party authorization forms were collected from each participating organization to authorize the utility companies to release historical utility data to the Iowa Energy Center for use in the project. After data were collected from the utilities (in some cases directly from organizations), the data format was checked and, if necessary, corrected. Then the data were imported into the B3 benchmarking system. Incomplete or questionable data were investigated to ensure data integrity before final analysis.

The 1,218 public buildings are categorized into 629 different “sites”. Each site can be benchmarked based on site type or building type. Statistics show that, if an ASHRAE 90.1-2007 energy code compliant building benchmarking ratio is 1.0, then:

- 84 sites (13.4%) have energy benchmarking ratio of 0.5 or below (meaning using 50% or less energy than an energy code-compliant building), resulting in 5 star benchmarking rating;
- 59 sites (9.4%) have energy benchmarking ratio between 0.5 and 0.63, resulting in 4 star rating;
- 121 sites (19.3%) have energy benchmarking ratio between 0.63 and 0.83, resulting in 3 star rating;
- 176 sites (28.1%) have energy benchmarking ratio between 0.83 and 1.25, resulting in 2 star rating;
- 95 sites (15.2%) have energy benchmarking ratio between 1.25 and 2.53, resulting in 1 star rating;
- 44 sites (7.0%) have energy benchmarking ratio between 2.53 and 10.0, resulting in no star rating;
- 47 sites (7.5%) are not able to be benchmarked because of various reasons (no 12 month continuous data yet, non-benchmark building type, etc.)

Overall, there are 232 sites (37%) out of 629 having a benchmarking ratio over 1.0. If by implementing energy efficiency measures these buildings’ benchmarking ratio can be improved to 1.0, the potential energy savings is estimated at over 300,000 MMBtu (million BTU) per year which is equivalent to an estimated energy dollar savings of over 3.9 million dollars per year.

Major challenges during the project initialization phase included identifying the appropriate contacts for each organization; matching buildings with the correct energy meter accounts; the authorization process between the utilities and the organizations; and data problem investigation. Because of the number of buildings, organizations, and utilities involved during the condensed period of the project, many of the project initialization problems were very detail-orientated and can only be solved by responsive management oversight on a case-by-case bases.
It is recommended that the B3 Benchmarking project continue beyond the pilot years because it provides Iowa-specific energy code benchmarks, automatic ratings from Energy Star Portfolio Manager, and historical building energy data to show peer to peer comparisons from a regional database. Benefits also include the ability of the system to provide for informed decision-making for utility companies and building owners and to provide a quick analysis of potential energy savings for targeted facilities. The system can identify those facilities that appear to have the greatest need for further investigation and provide the greatest potential for energy improvement as benchmarked against a code-base model of similar building types and peer comparisons. For building science research in Iowa, the system can also provide an expanding, rich database for research centered on increasing energy efficiency in Iowa and the nation. Most importantly, it can be used to identify high ROI building projects to inform retrofit improvement programs operated by utilities, state, and performance contracting organizations in the State of Iowa. Future suggested steps for continuing the benchmarking project include expanding the number of buildings in the benchmarking platform, and integrating the platform into the process of planning, financing, implementing and validating energy efficiency programs and projects in the State of Iowa.
1. INTRODUCTION

1.1. Background

Buildings must improve energy efficiency in order to significantly reduce U.S. building energy use, as it accounts for almost 41% of U.S. primary energy use. Building energy benchmarking calculates a building’s Energy Utilization Index or Energy Use Intensity (EUI), and offers an initial building energy performance assessment to inform if an energy auditing process or more detailed analysis may be needed. It is useful for property owners, facilities operators, building designers, and especially the utilities. It facilitates energy accounting, assesses opportunities for improvement, and quantifies and verifies energy savings. The State of Iowa does not have a database for tracking building energy performance, and this pilot project was an effort to create an initial energy benchmarking database for 1,218 public buildings, estimated to be approximately 20% of the public building stock, to demonstrate the potential for increasing awareness and informed decision-making. The public building sectors included city, county, K-12, community colleges, and state-owned facilities.

In September 2010, the State of Iowa Office of Energy Independence entered into an agreement with Iowa State University to have the Iowa Energy Center conduct a public building energy benchmarking pilot project. The pilot project goals were to:

- Demonstrate an energy benchmarking pilot process state-wide for public facilities, and develop experience on how to engage building owners and best gather building energy data in the state of Iowa;
- Create an initial database of Iowa public buildings for continued case-study and research on building energy efficiency, and allow the state to assess the current energy usage for public buildings;
- Create a framework for informed decision-making, identify which buildings are good candidates for high Return On Investment (ROI) for energy efficiency improvement projects;
- Provide recommendations for future energy benchmarking process improvements and long term project plan;
- Increase public awareness on building energy usage.

The pilot benchmarking scope defined a process to collect, measure, and compare actual building consumption to expected consumption for a minimum of 1,000 public buildings throughout the state. The future concept of this effort is to identify a population of buildings that are using more energy than expected to target energy improvement programs with high ROI potential to evaluate and implement improvements. Energy consumption would then be tracked to measure and verify expected performance. The overview of the benchmarking project is illustrated in Figure 1.
The importance of the benchmarking project to Iowa includes piloting a system to:

- present an inventory of building energy use in the state of Iowa;
- provide information for the design of efficiency programs;
- provide information for Iowa specific building energy efficiency research - which is more valuable than secondary data currently used;
- provide a system that addressed the existing building stock – existing buildings are long-term and permanent;
- provide an organized / collective method of gathering information to provide more informed long-term planning;
- assist with a long-term movement for improvement – already pressures to improve;
- create an Iowa database – as compared to the national Energy Star Portfolio Manager database.

1.2. Objectives

Besides the overarching goals stated in the previous section, the objectives for this project are as follows:

- Establish and demonstrate an effective process to conduct a state-wide building energy benchmarking project;
• Develop a “human network” for participating public organizations and related utilities;
• Evaluate different benchmarking system vendors and determine a good benchmarking system (software platform) that is suitable for this project;
• Collect building energy data from the utilities and organizations and import them into the benchmarking system to establish an initial database of building inventory and energy data;
• Result analysis and identify which buildings are good candidates for high ROI and quantify the energy savings potential, as compared to a program that selects building improvement projects on a request basis or at random;
• Develop experience on how to best gather data and engage building owners in the state of Iowa for the benchmarking project;
• Have an orderly and credible “road map” plan for managing improvements and investments in all state buildings over multiple years and multiple funding cycles;
• Provide recommendations for future energy benchmarking process improvements and long term project plan.
2. METHODOLOGY AND PROCESS

2.1. Methodology

The methodology to reach the objectives of the pilot project started with the formation of a Benchmarking Stakeholder Advisory Group to guide and obtain feedback on the development of the project. It was determined that besides the benchmarking ratio (defined by the ratio of building energy consumption compared to an energy-code compliant building of the same size and building type), the Energy Star Portfolio Manager rating is used for applicable building types too. The benchmarking process and project structure were developed based on the general approach and data requirement by the Energy Star Portfolio Manager benchmarking protocol.

2.2. Process

A six-step benchmarking process was used in this pilot project:

1) Identify team and structure including BSAG members, public building sectors, project team members, and organization and utility contact information;
2) Advertise a Request For Proposal (RFP) and select the best-suited benchmarking platform for the project;
3) Initiate project start-up, begin building inventory, customize software, and develop roll-out campaign;
4) Training;
5) Data collection, import and verification;
6) Data analysis.

2.2.1. Identifying Team and Structure

The first step included identifying the key benchmarking stakeholders to include in the BSAG, develop a list of all public building organizations by sector and all utility companies in Iowa with contact names, phone numbers, and email addresses. The public sectors utilized for the project included city, county, K-12, community colleges and state-owned facilities. For effective input, collaboration, and communication, the BSAG was organized and included representatives from the following organizations:

a) Iowa Utility Board
b) Office of Consumer Advocate
c) Iowa Utility Association
d) Iowa Association of Electric Cooperatives
e) Iowa Association of Municipal Utilities
f) MidAmerican Energy
g) Alliant Energy
h) Black Hills Energy
i) Iowa Association of Counties
j) Iowa League of Cities
k) Iowa Department of Education
l) Department of Public Safety – Building Code
m) Department of Administrative Services
n) Iowa Association of School Boards
o) Iowa Department of Transportation
p) Iowa Office of Energy Independence
q) Board of Regents

Given the goal of benchmarking 1,000 buildings during the relatively short project period, an organizational structure was developed to provide sector leaders as the communication and management link between sector organizations and the project leadership at the Iowa Energy Center. A request for proposal was forwarded to the Regents Institutions in Iowa requesting proposals from interested research faculty to serve as sector leaders. Jeff Beneke from the University of Northern Iowa responded with expertise in the K-12 sector. A second advertisement was distributed within Iowa State University to determine student participants for the remaining sector leaders representing city, county, community college and state sectors. The organizational structure is shown in Figure 2 below.

Figure 2. Benchmarking Project Structure
2.2.2. Request for Proposal and Selection of Benchmarking Platform

A benchmarking software application Request for Proposal (RFP) was developed to select a contractor to provide both an energy benchmarking application, a proposed solution and plan of work, and related management and support services for the duration of the project. The Iowa Energy Center, the BSAG, and the Iowa State University Purchasing Department developed the criteria, scope of work, and conducted the review of proposals and ultimate selection of the contractor in September 2010. Criteria and scope followed the framework developed by ASHRAE research project technical report TRP-1286 “Evaluation of Building Energy Performance Rating Protocols” (Glazer 2006) which included at minimum:

- Emphasis on ease-of-use for non-technical owners;
- Make it easy to update and add new data;
- Tool should be web-based;
- Provide simple graphical input;
- Link to simulation-based design compliance with an ASHRAE Energy Code standard;
- Include CO2 emissions;
- Provide weather normalization;
- Portfolio option for multiple buildings;
- Utility data upload;
- Provide on-line training;
- Consistent floor area designations.

Based on the evaluation criteria, the B3 Benchmarking system proposed by The Weidt Group from Minnetonka, Minnesota and Des Moines, Iowa was selected from a group of six proposals received. The B3 Benchmarking system is designed specifically to conduct state-wide public building benchmarking programs and has been used to benchmark over 6,400 buildings in the State of Minnesota for the past 9 years. It has an organizational structure of public building sectors for K-12 Schools, Cities, Counties, Community Colleges, and State agencies and benchmark models that represent the entire building type portfolio found within each of those sectors. It has tools for finding and tracking prospects that assist in managing the human network. It provides energy simulation-based benchmark comparison for all buildings to the current Iowa energy code, energy baseline comparison showing how a building’s current and historic consumption and costs compare, automatic Energy Star Portfolio Management ratings, as well as a new regional building B3 Peer percentile ranking.

The B3 Benchmarking services and data acquisition functions are delivered via a website application. Building data owners can enter and view their building results using a password protected website. The internet application is an effective method for gathering data for the following capabilities:

- Provides instant feedback to the data entry process for validation.
• Rewards the Stakeholder immediately for their efforts.
• Provides interaction with the data repository in which the Stakeholder can manage their building data.

The B3 program provides a unique benchmark for each building. By comparing a building’s actual energy consumption from all fuel sources to its unique benchmark, the opportunity for energy savings can be determined. By then comparing opportunity across buildings, a prioritized list of buildings that offer the highest potential for cost effective improvements for energy consumption is determined. This systematic method of comparison helps managers justify and win the funds necessary to complete further analysis through energy audits and, ultimately, energy conservation upgrades.

Four types of energy comparisons for building sites are conducted:

• **Benchmark Comparison**: shows if a building site is using more or less energy than expected as compared to a similar building designed to the current Iowa energy code.
• **Peer Comparison**: identifies a percentile ranking of the building compared to like buildings within a regional database.
• **Energy Star Portfolio Manager**: displays the percentile rating of the building to like buildings within a U.S. national database.
• **Baseline Comparison**: shows how the building is currently operating as compared to a previous consumption period for the building.

Figure 3 shows a screen view of the four types of comparison methods inside the application for a typical project at “Site” level:
The user interface design is straightforward and simple to use, based on years of user feedback, and refinement. The current interface is written in MS Silverlight - a new Rich Internet Application (RIA) to provide excellent data entry, reporting, and graphing capabilities. Typically an hour long training session with a person not versed in building energy consumption is enough time for them to accurately enter data and understand results.

2.2.3. Initiate Project Start-up and Develop Roll-out Campaign

Between November 2010 and March 2011, the initial project start-up phase included customizing the website to include Iowa Energy Center and Iowa-specific data regarding process, communications, and branding. In addition, the benchmarking application was customized to include building energy models for each building type modified from Minnesota to Iowa climate data. During this project start-up phase the team leaders and sector leaders began to estimate a building inventory from the list of
organizations in each sector in an effort to statistically select a random sample of organizations and related buildings to achieve the 1,000 building goal for the project. During this effort, it was determined that given the tight schedule, a better method for seeking participation from organizations was to organize a roll-out campaign primarily through email blasts to organizational contact lists developed with the aid of the BSAG. It was also determined during this phase that the web-site would be used as the primary nexus for communication between the organizations and the project team. The roll-out campaign was conducted to all organization contacts from all sectors in the B3 system from March 28 – April 29, 2011. Organizations interested in participating in the pilot project were to respond via the website by confirming their organization and contact information and by providing an estimate of building numbers and area they control for their organization. Through this one month roll-out campaign, initially 66 organizations expressed interest in the project representing an estimated 3,340 buildings with an estimated building area of 43,008,000 square feet. The final participant listing included in the project with representative buildings and utilities are listed in Table 1 and Table 2 respectively.

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<td>3</td>
<td>18</td>
</tr>
<tr>
<td>Community College</td>
<td>Des Moines Area Community College</td>
<td>42</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>Easter Iowa Community College District</td>
<td>1</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Iowa Lakes Community College</td>
<td>36</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>Kirkwood Community College</td>
<td>10</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>Northwest Iowa Community College</td>
<td>9</td>
<td>23</td>
</tr>
<tr>
<td>County</td>
<td>Buchanan</td>
<td>8</td>
<td>24</td>
</tr>
<tr>
<td>Utility Category</td>
<td>Utility Name</td>
<td>Energy Source Type</td>
<td>Counts</td>
</tr>
<tr>
<td>----------------------------------------------</td>
<td>-------------------------------------------------------</td>
<td>------------------------------</td>
<td>--------</td>
</tr>
<tr>
<td>Investor-owned Utilities (IOU)</td>
<td>Alliant Energy - IPL</td>
<td>Electric &amp; Natural Gas</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Black Hills Energy</td>
<td>Natural Gas</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>MidAmerican Energy Company</td>
<td>Natural Gas</td>
<td>3</td>
</tr>
<tr>
<td>Iowa Association of Electric Cooperatives (IAEC)</td>
<td>Allamakee Clayton Electric Cooperative, Inc.</td>
<td>Electric</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Clarke Electric Cooperative, Inc.</td>
<td>Electric</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Consumers Energy Cooperative</td>
<td>Electric</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Farmers Electric Cooperative, Inc.</td>
<td>Electric</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Hawkeye REC</td>
<td>Electric</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Linn County Rural Electric</td>
<td>Electric</td>
<td>9</td>
</tr>
</tbody>
</table>

Table 2. Participating Utilities
<table>
<thead>
<tr>
<th>Iowa Association of Municipal Utilities (IAMU)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooperative Association</td>
<td></td>
</tr>
<tr>
<td>North West Rural Electric Cooperative</td>
<td>Electric</td>
</tr>
<tr>
<td>Southwest Iowa Rural Electric Cooperative</td>
<td>Electric</td>
</tr>
<tr>
<td>Algona Municipal Utilities</td>
<td>Electric</td>
</tr>
<tr>
<td>Ames Municipal Electric System</td>
<td>Electric</td>
</tr>
<tr>
<td>Atlantic Municipal Utilities</td>
<td>Electric</td>
</tr>
<tr>
<td>Cedar Falls Utilities</td>
<td>Natural Gas</td>
</tr>
<tr>
<td>Corning Municipal Utilities</td>
<td>Natural Gas</td>
</tr>
<tr>
<td>Denison Municipal Utilities</td>
<td>Electric</td>
</tr>
<tr>
<td>Emmetsburg Municipal Utilities</td>
<td>Natural Gas</td>
</tr>
<tr>
<td>Estherville, City of</td>
<td>Electric</td>
</tr>
<tr>
<td>Grundy Center Municipal Utilities</td>
<td>Electric</td>
</tr>
<tr>
<td>Guttenberg Municipal Electric</td>
<td>Electric</td>
</tr>
<tr>
<td>Harlan Municipal Utilities</td>
<td>Electric &amp; Natural Gas</td>
</tr>
<tr>
<td>Hawarden Municipal Utilities</td>
<td>Electric &amp; Natural Gas</td>
</tr>
<tr>
<td>Independence Light &amp; Power</td>
<td>Electric</td>
</tr>
<tr>
<td>Maquoketa Municipal Electric Utility</td>
<td>Electric</td>
</tr>
<tr>
<td>Mt. Pleasant Utilities</td>
<td>Electric</td>
</tr>
<tr>
<td>Muscatine Power &amp; Water</td>
<td>Electric</td>
</tr>
<tr>
<td>New Hampton Municipal Light Plant</td>
<td>Electric</td>
</tr>
<tr>
<td>Orange City, City of</td>
<td>Electric &amp; Natural Gas</td>
</tr>
<tr>
<td>Osage Municipal Utilities</td>
<td>Electric &amp; Natural Gas</td>
</tr>
<tr>
<td>Pocahontas Municipal Utilities</td>
<td>Electric</td>
</tr>
<tr>
<td>Rock Rapids Municipal Utilities</td>
<td>Electric &amp; Natural Gas</td>
</tr>
<tr>
<td>Sioux Center, City of</td>
<td>Electric &amp; Natural Gas</td>
</tr>
<tr>
<td>Spencer Municipal Utilities</td>
<td>Electric</td>
</tr>
<tr>
<td>Tipton, City of</td>
<td>Electric &amp; Natural Gas</td>
</tr>
<tr>
<td>Vinton Municipal Electric Utilities</td>
<td>Electric</td>
</tr>
<tr>
<td>Waverly, City of</td>
<td>Electric</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Others</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriland FS</td>
<td>Propane</td>
</tr>
<tr>
<td>AgVantage FS</td>
<td>Propane</td>
</tr>
<tr>
<td>Atmos Energy Corporation</td>
<td>Natural Gas</td>
</tr>
<tr>
<td>Constellation Energy</td>
<td>Natural Gas</td>
</tr>
<tr>
<td>Fauser Energy Resources</td>
<td>Propane</td>
</tr>
<tr>
<td>Fenci Oil &amp; LP Co., Inc.</td>
<td>Propane</td>
</tr>
<tr>
<td>Ferrellgas</td>
<td>Propane</td>
</tr>
<tr>
<td>K &amp; H Cooperative Oil</td>
<td>Propane</td>
</tr>
<tr>
<td>Osage Co-op Elevator</td>
<td>Propane</td>
</tr>
<tr>
<td>Seminole Energy Services</td>
<td>Natural Gas</td>
</tr>
<tr>
<td>Three Rivers FS</td>
<td>Propane</td>
</tr>
<tr>
<td>UNI Power Plant</td>
<td>Electric, Steam/Hot Water</td>
</tr>
</tbody>
</table>
2.2.4. Training

Once organization participants were identified and connections created between building owners and sector leaders, training sessions with sector leaders on the B3 Benchmarking application were conducted to make sure they were familiar with the user interface and general operations of the software platform. Training ensured that initial data about organization, demographics, contact person, and basic building information would be correctly entered into the system. Additional training sessions with the organization “data owners” were later conducted between June and August 2011 to describe the general features of the B3 benchmarking system as well as the data collection process and schedule (described in the next section).

2.2.5. Data Collection, Import and Verification

Data collection and verification was another critical step for the pilot project. Building and building energy data had to be accurately and quickly collected and imported into the benchmarking platform. Because of the number of buildings (over 1200) involved, the following process was used to effectively collect building physical and energy data:

1) Sector leaders contacted each organization within the sector to obtain basic building information (name, building type, and area, etc.) in concert with basic meter information (account and meter numbers, and utility companies that serve the building). Building data acquisition using standard building input templates were filled out by each organization and uploaded by The Weidt Group into the B3 Benchmarking application.

2) For each organization, an authorization form was compiled listing each account for which consumption data would be requested from the specific utility company. The form was then signed by both the organization and the Iowa Energy Center to authorize the utility company to provide energy data to the Iowa Energy Center for use in the project.

3) The Iowa Energy Center collected authorization forms from all organizations and compiled and categorized the forms by utility, and then contacted each utility to request related electric and natural gas energy data as well as billing information for the previous three year period. When requesting data, an energy data template was sent with the authorization form(s) so the utility companies could send the data back in a format that could be easily imported into the B3 Benchmarking platform.

4) Because of the variety of internal energy/billing systems used by the utilities, all data obtained from the utilities did not fit the format of the data template. Over six custom data import templates, specific to each utility, was created to import meter consumption data.
2.2.6. Data Analysis

The data analysis was the final step of the project. Once all data was imported to the system, the B3 benchmarking application calculated each building’s 1) Benchmark ratio (actual current EUI compared to the ASHRAE 90.1-2007 code-compliant building simulation EUI result); 2) Energy Star Portfolio Manager rating for applicable building types; 3) Peer percentile ranking comparison to like buildings in the database; and 4) Baseline energy comparisons of current consumption to a previous baseline year’s consumption.

The benchmarking ratios can be categorized by sector and by utility and can be stacked rank from high to low performance. Buildings with extreme high and low benchmarking ratios were double checked, verified, and/or corrected before they are included in the final result analysis. Each building’s energy savings potential is shown in the B3 Benchmarking application by calculating the difference in Actual EUI to the Benchmark EUI and then multiplying by the buildings floor area. The detailed data analysis is described in Chapter 3.
3. RESULTS

3.1. Characteristics of Pilot Project Population

The pilot project represents data for 53 public organizations encompassing 1,218 buildings, 1,676 meters and over 32 million square feet of floor area in all five public building sectors surveyed. It is estimated that the pilot project represents from 15 to 20 percent of all public buildings in the State of Iowa. Since the sample of buildings was created by a voluntary invitation, and not randomly selected, we do not know if the pilot sample is statically representative of the remaining public building population. Table 3 identifies the major building characteristics by sector.

Table 3. Pilot Building Characteristics by Sector

<table>
<thead>
<tr>
<th>Sector</th>
<th>Floor area SF</th>
<th>% Floor Area</th>
<th>Number of Sites</th>
<th>Number of Buildings</th>
<th>Avg Buildings per Site</th>
<th>Average SF per Building</th>
<th>Number of Meters</th>
</tr>
</thead>
<tbody>
<tr>
<td>City</td>
<td>3,053,750</td>
<td>9%</td>
<td>123</td>
<td>125</td>
<td>1.02</td>
<td>24,430</td>
<td>290</td>
</tr>
<tr>
<td>Community Colleges</td>
<td>2,457,257</td>
<td>8%</td>
<td>52</td>
<td>98</td>
<td>1.88</td>
<td>25,074</td>
<td>161</td>
</tr>
<tr>
<td>County</td>
<td>706,447</td>
<td>2%</td>
<td>32</td>
<td>34</td>
<td>1.06</td>
<td>20,778</td>
<td>78</td>
</tr>
<tr>
<td>K-12 Public Schools</td>
<td>12,682,273</td>
<td>39%</td>
<td>183</td>
<td>173</td>
<td>0.95</td>
<td>73,308</td>
<td>525</td>
</tr>
<tr>
<td>State</td>
<td>13,710,149</td>
<td>42%</td>
<td>239</td>
<td>788</td>
<td>3.30</td>
<td>17,399</td>
<td>622</td>
</tr>
<tr>
<td>Total</td>
<td>32,609,876</td>
<td>100%</td>
<td>629</td>
<td>1,218</td>
<td>1.94</td>
<td>26,773</td>
<td>1,676</td>
</tr>
</tbody>
</table>

The K-12 Public Schools and State sectors represent over 80% of the floor area and 79% of the number of buildings in the pilot sample. The average building size is similar for City, County and State sector buildings varying from 17,000 SF to 25,000 SF, but is much higher for the K-12 Public School sector at 73,000 SF.

One key observation displayed in Table 3 shows that the City, County, and K-12 sectors have on average one building per site, meaning that most buildings are stand alone and have separate meters. However, Community Colleges and State building have on average nearly 2 to over 3 buildings per site, meaning they have many conditions where each building is not separately metered. The later condition is typical of organizations that have campuses or remote sites with multiple buildings served by one utility revenue meter without sub metering to account for specific building energy consumption.

3.2. Energy Savings Potential of Buildings by Sector

Table 4 identifies an estimate of potential energy savings for existing buildings that have high benchmark ratios by sector. The table is automatically generated using the B3 Benchmarking system to query buildings by sector that have actual energy consumption EUI exceeding their expected energy code benchmark EUI, then subtracting the difference in EUI and multiplying by the building square feet to calculate Potential Savings in MMBTU/Year. The quantity of potential improvement buildings, floor area and savings is a technical
planning estimate, to understand the magnitude of and percentage of buildings that could be improved cost-effectively.

Table 4. Energy Savings Potential by Sector

<table>
<thead>
<tr>
<th>Sector</th>
<th>Potential Improvement Buildings</th>
<th>Building %</th>
<th>Potential Improvement SF</th>
<th>SF %</th>
<th>Potential Savings (MMBTU/YR)</th>
<th>Potential Annual Dollar Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>City</td>
<td>45</td>
<td>36%</td>
<td>1,313,883</td>
<td>43%</td>
<td>41,059</td>
<td>$533,769</td>
</tr>
<tr>
<td>Community Colleges</td>
<td>16</td>
<td>16%</td>
<td>430,563</td>
<td>18%</td>
<td>9,570</td>
<td>$124,414</td>
</tr>
<tr>
<td>County</td>
<td>15</td>
<td>44%</td>
<td>209,639</td>
<td>30%</td>
<td>8,706</td>
<td>$113,181</td>
</tr>
<tr>
<td>K-12 Public Schools</td>
<td>49</td>
<td>28%</td>
<td>3,157,207</td>
<td>25%</td>
<td>41,807</td>
<td>$543,497</td>
</tr>
<tr>
<td>State</td>
<td>395</td>
<td>50%</td>
<td>6,776,289</td>
<td>49%</td>
<td>198,982</td>
<td>$2,586,760</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>520</strong></td>
<td><strong>43%</strong></td>
<td><strong>11,887,581</strong></td>
<td><strong>36%</strong></td>
<td><strong>300,124</strong></td>
<td><strong>$3,901,612</strong></td>
</tr>
</tbody>
</table>

The table identified that 36% of the floor area surveyed in the pilot exceed their Benchmark EUI, and if improved to theoretically operate at the Benchmark EUI, could save over 300,000 MMBtu per year, representing over 3.9 million dollars in annual savings potential.

3.3. Energy Savings Potential by Utility Combination

Meter consumption data was gathered from forty-nine utilities. A review of savings potential by utility company is shown in Table 5. The columns are identical to Table 4, except the opportunities are queried by the utility combination serving both electricity and natural gas to each building site. There are a total of 57 different combinations of electric and natural gas companies serving all buildings. In Table 5, the top 12 combinations by number of buildings are identified. All 55 different combinations of electric and natural gas companies’ savings potential are presented.
### Table 5. Energy Savings Potential by Utility Combination

<table>
<thead>
<tr>
<th>Utility Electric / Gas</th>
<th>Potential Improvement Buildings</th>
<th>Building %</th>
<th>Potential Improvement SF</th>
<th>SF %</th>
<th>Potential Savings (MMBTU/YR)</th>
<th>Potential Annual Dollar Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>MidAmerican Energy Company / MidAmerican Energy Company</td>
<td>109</td>
<td>38%</td>
<td>3,564,029</td>
<td>34%</td>
<td>38,562</td>
<td>$501,300</td>
</tr>
<tr>
<td>MidAmerican Energy Company / Constellation Energy</td>
<td>82</td>
<td>93%</td>
<td>1,179,892</td>
<td>89%</td>
<td>6,385</td>
<td>$83,005</td>
</tr>
<tr>
<td>Alliant Energy - IPL / Alliant Energy - IPL</td>
<td>72</td>
<td>42%</td>
<td>754,385</td>
<td>45%</td>
<td>8,793</td>
<td>$114,315</td>
</tr>
<tr>
<td>Alliant Energy - IPL / Black Hills Energy</td>
<td>50</td>
<td>52%</td>
<td>414,757</td>
<td>34%</td>
<td>17,920</td>
<td>$232,966</td>
</tr>
<tr>
<td>Alliant Energy - IPL / MidAmerican Energy Company</td>
<td>39</td>
<td>50%</td>
<td>401,630</td>
<td>20%</td>
<td>6,795</td>
<td>$88,332</td>
</tr>
<tr>
<td>MidAmerican Energy Company / Black Hills Energy</td>
<td>29</td>
<td>59%</td>
<td>479,381</td>
<td>29%</td>
<td>4,343</td>
<td>$56,463</td>
</tr>
<tr>
<td>Alliant Energy - IPL / Seminole Energy Services</td>
<td>19</td>
<td>35%</td>
<td>1,458,838</td>
<td>42%</td>
<td>21,663</td>
<td>$281,620</td>
</tr>
<tr>
<td>UNI Power Plant /</td>
<td>18</td>
<td>43%</td>
<td>1,528,164</td>
<td>40%</td>
<td>147,659</td>
<td>$1,919,573</td>
</tr>
<tr>
<td>Consumers Energy Cooperative / Alliant Energy – IPL</td>
<td>11</td>
<td>100%</td>
<td>36,755</td>
<td>100%</td>
<td>507</td>
<td>$6,596</td>
</tr>
<tr>
<td>MidAmerican Energy Company / Alliant Energy – IPL</td>
<td>10</td>
<td>29%</td>
<td>50,668</td>
<td>6%</td>
<td>1,594</td>
<td>$20,725</td>
</tr>
<tr>
<td>Denison Municipal Utilities / Black Hills Energy</td>
<td>9</td>
<td>90%</td>
<td>29,232</td>
<td>56%</td>
<td>96</td>
<td>$1,242</td>
</tr>
<tr>
<td>Mt. Pleasant Utilities / Alliant Energy – IPL</td>
<td>9</td>
<td>90%</td>
<td>23,624</td>
<td>57%</td>
<td>130</td>
<td>$1,686</td>
</tr>
</tbody>
</table>

3.4. Energy Star Portfolio Manager Rating

The percentage of buildings that can receive an Energy Star Portfolio Manager Percentile rating is graphed by sector in Figure 4. The Energy Star Portfolio Manager system provides a percentile ranking applicable to buildings that can be described by 15 different building types based on a statistical significant sample size from the U.S. Commercial Buildings Energy Consumption Survey (CBECS). The K-12 Public School sector shows most buildings can be scored using the Energy Star Portfolio Manager system, while the
other sectors show a lower percentage of building types that can be scored using the Energy Star Portfolio Manager percentile ranking system.

![Graph showing percentage of buildings scored using Energy Star Portfolio Manager by sector](image)

**Figure 4. Percent of Buildings Scored Using Energy Star Portfolio Manager by Sector**

### 3.5. Sample Data Analysis at Organization Level

There are three levels of data details/statistics in the B3 system in terms of organization hierarchy: Sector level, Organization level, and Site level. At Sector level, the number of sites, buildings, total square footage, and number of meters are summarized for each sector and will not be discussed in details in this report.

At Organization level, the B3 Benchmarking system provides an organization the ability to manage their existing building energy consumption with simple reports using monthly utility billing information and some basic facility data about their building so they can easily identify which of their building sites are:

- Consuming more or less energy than expected – the B3 **Benchmarks** view
- Consuming more or less energy than similar buildings in the B3 system - the B3 **Peer Comparison** view
- Consuming more or less energy than similar buildings nationwide - the **ENERGY STAR** view
- Consuming more or less energy than in a previous 12-month period – the **Baselines** view

Knowing which building sites use more energy than expected identifies which buildings are cost-effective candidates for energy retro-commissioning or retrofit projects. Knowing which buildings are consuming more or less energy than in previous years allows the organization to know which buildings to focus attention on right away to determine what is
required to maintain or improve its energy consumption.

A sample B3 Benchmarking overview at organization level is provided below. Similarly, the Appendix A provides a sample B3 Benchmarking overview at Site level.

3.5.1. Summary Tab

As shown in Figure 5, the summary view displays high-level organizational information and completeness. “Complete” means every site must have at least one complete building, one meter, and 12 months of energy consumption data. “Incomplete” means either the site is a “non-building” (tennis court, open garage, etc.) or there is missing data

- Correct: building properties, consumption data and operational properties must fall within viable ranges
- Contiguous: the minimum 12 months of consumption data must be contiguous
- Current: recent data is most valuable
- Missing data for the organization is summarized in the top right corner. The example below shows this organization has multiple sites, 1 building for each site, and 1 “non-building”. The lower panel summarizes sites/buildings’ basic information and the contiguousness and recentness of the meter data.
3.5.2. Benchmark Tab

The Benchmark view identifies which buildings are using more energy than expected as compared to a typical building of similar space activities meeting the design requirements of the current Iowa Energy Code (ANSI/ASHRAE/IESNA Standard 90.1-2007 for the pilot project). The more accurate the building data is, the more accurate the model will be. The benchmark ratio is the actual meter consumption divided by the predicted consumption from the model, so a benchmarking ratio of 1.0 representing an energy code-compliant building. Those buildings with higher ratios will have the highest potential energy savings and potentially yield the highest return on investment of funds spent on energy performance improvements.

The top panel shows the organization's energy consumption by fuel source as compared to the Benchmark total. In the example below, the completed sites for the
organization are using 25.66 kBtu/SF/Year for electricity, and 36.52 kBtu/SF/Year for natural gas. The organization’s composite benchmark consumption is 62.18 kBtu/SF/Year for completed sites.

In Figure 6, the lower panel displays a list of the organization’s sites sorted by the benchmark ratio. Sites at the top of the list may be using more energy than they should. Those sites are great candidates for energy assessments. In the example below, the second site in the list (Polk elementary school) shows an Actual total of 72.34 kBtu/SF/Year and a Benchmark total of 80.50 kBtu/SF/Year, which results in a B3 benchmark ratio of 0.90.

![Benchmark Tab](image-url)

**Figure 6. Benchmark Tab**
3.5.3. Peer Comparison Tab

Figure 7 shows the Peer Comparison view that displays how a site compares to another site within B3 of similar space usages. Peer sites are determined by having the same space type usage or similar space type usage within a certain tolerance. If there are not enough similar sites, a peer comparison rating is not available.

![Peer Comparison Tab](image)

**Figure 7. Peer Comparison Tab**

3.5.4. ENERGY STAR Tab

The ENERGY STAR tab allows you to obtain an ENERGY STAR rating for eligible sites.
If a site is eligible, the ENERGY STAR rating will appear here. If the site is ineligible, the red status icon will explain why. In the example below (Figure 8), the Hoover Elementary School received a rating of 74 while their other sites have other ratings.

Figure 8. ENERGY STAR Tab

3.5.5. Baseline Tab

The Baseline view allows you to stack rank your portfolio of sites to show which buildings are currently using more or less energy compared to a previous Baseline year. Baselines are used primarily to track savings from improvement projects, or manage the site’s energy performance on an on-going basis.

The example below has a baseline year of January 2010 – December 2010. This can be changed by clicking orange date range and selecting a new 12 month period. This
establishes the “Baseline” performance for each site within the organization.

The Figure 9 top panel shows how the organization is performing against the baseline in regards to Energy (kBtu/SF/year), Dollars ($/SF/year) and CO2 (lbs/SF/year). In the example below, the school district is currently using 6.28% more energy, 0.48% more energy costs, and increased their CO2 emissions by 6.28% as compared to their baselines. A stack rank of the site’s current energy consumption as compared to the weather normalized Baseline is displayed in the bottom panel with the poorer performers on top. In the example below, the first site is currently using 4.12% more energy than the baseline while the twelfth site is using 1.1% less energy.

To calculate the baseline, B3 Benchmarking takes the sites’ consumption during the baseline year and weather normalizes that to other years for comparison to actual consumption. For example, if the baseline year is 2010 and you are viewing 2011 data, B3 Benchmarking will display actual 2011 consumption as a solid line, and the 2010 consumption normalized to 2010 weather as a dashed line. Because B3 Benchmarking has removed weather as a variable, you are able to see the change in energy performance due to non-weather factors such as occupancy, operation, or changes to the building systems or components. If you have improved any of these items, the result will be a reduction in consumption, or “savings.”
3.5.6. Target Tab

As shown in Figure 10, the Target view allows you to set goals, both relative and absolute, for the organization and sites. The table below allows you to define the targets. You can monitor your targets against actual consumption on the Reports tab. For more detail please refer to the Appendix A.

![Figure 10. Targets Tab](image)

3.5.7. Reports Tab

The Reports view (Figure 11) allows you to visualize the energy performance of an organization, or a specific site, from one year to the next for all fuel sources, in dollars, carbon dioxide emissions, native units, or kBtus. The default report is the Total Energy Dashboard. However there are other reports and options to compare current, baseline and target consumption metrics. These reports and options are shown in Appendix B.

The report below displays actual monthly EUI in kBtu/SF/Year for both electricity and natural gas as blue and red bars as compared to the weather normalized baseline as the dashed line. The baseline period is January 2010 – December 2010.
3.6. Sample B3 Benchmarking Statistics by Sector/Organization/Site

Organizations can benefit from the B3 Benchmarking system by finding out the organizations/buildings/sites with the highest potential for improving energy performance, and plan energy efficiency projects to focus on those buildings first. A sample B3 Benchmarking statistics by sector/organization/site is shown as examples in this section.

3.6.1. A Sample Data Statistics

A sample data statistics table is shown in Table 6. This table shows the building energy related statistics for public buildings in the city of Bondurant and some public buildings in the city of Cedar Rapids. Statistics in the table include organization name and sector, site name, current space area in square feet, primary space type, actual energy use intensity (EUI) in kBtu/SF/Year, benchmark EUI in kBtu/SF/Year, B3 energy benchmarking Ratio, B3 Benchmarking start rating in the range of 1 to 5, and potential
energy savings in kBtu (if can bring the buildings that have EUI > 1.0 to EUI = 1.0). In the table, the building with B3 Benchmarking ratio of 0.0 is either cannot be benchmarked because it’s a “non-building” type (e.g. open air parking ramp, baseball field, etc.) or the building is newly built or occupied therefore there is no continuous 12-month data available.

All Benchmarking statistics by sector/organization/site are listed as a separate document entitled “Building Energy Benchmarking Pilot Project Results”.

<table>
<thead>
<tr>
<th>Organization Name</th>
<th>Site Name</th>
<th>Current SF</th>
<th>Primary Space Usage</th>
<th>Actual kBtu/SF/Yr</th>
<th>Benchmark kBtu/SF/Yr</th>
<th>Benchmarking Ratio</th>
<th>Benchmark Rating (Stars)</th>
<th>Potential Savings kBtu/Yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>City, Bondurant</td>
<td>Second Street Shop</td>
<td>4,032</td>
<td>Parking Garage</td>
<td>33.58</td>
<td>18.68</td>
<td>1.80</td>
<td>1.39</td>
<td>60,092</td>
</tr>
<tr>
<td>City, Bondurant</td>
<td>Main City Shop</td>
<td>3,000</td>
<td>Machine Shop</td>
<td>111.77</td>
<td>93.18</td>
<td>1.20</td>
<td>2.08</td>
<td>55,758</td>
</tr>
<tr>
<td>City, Bondurant</td>
<td>City Hall (aka Community Center)</td>
<td>4,275</td>
<td>City Hall</td>
<td>72.79</td>
<td>91.85</td>
<td>0.79</td>
<td>3.15</td>
<td>0</td>
</tr>
<tr>
<td>City, Cedar Rapids</td>
<td>5 Seasons Parkade</td>
<td>358,174</td>
<td>Open Air Parking Ramp</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0</td>
</tr>
<tr>
<td>City, Cedar Rapids</td>
<td>Green House</td>
<td>5,844</td>
<td>Greenhouse</td>
<td>406.58</td>
<td>269.25</td>
<td>1.51</td>
<td>1.66</td>
<td>802,547</td>
</tr>
<tr>
<td>City, Cedar Rapids</td>
<td>Montessori School</td>
<td>15,038</td>
<td>Elementary School</td>
<td>114.29</td>
<td>81.23</td>
<td>1.41</td>
<td>1.78</td>
<td>497,119</td>
</tr>
<tr>
<td>City, Cedar Rapids</td>
<td>Ice Arena</td>
<td>91,000</td>
<td>Ice Arena</td>
<td>242.58</td>
<td>178.67</td>
<td>1.36</td>
<td>1.84</td>
<td>5,815,914</td>
</tr>
<tr>
<td>City, Cedar Rapids</td>
<td>Police Station</td>
<td>66,725</td>
<td>Police Facility</td>
<td>163.19</td>
<td>121.78</td>
<td>1.34</td>
<td>1.87</td>
<td>2,762,969</td>
</tr>
<tr>
<td>City, Cedar Rapids</td>
<td>Fire Station #6</td>
<td>3,424</td>
<td>Fire Station</td>
<td>116.78</td>
<td>89.88</td>
<td>1.30</td>
<td>1.92</td>
<td>92,093</td>
</tr>
<tr>
<td>City, Cedar Rapids</td>
<td>GTC Parkade</td>
<td>175,325</td>
<td>Open Air Parking Ramp</td>
<td>7.66</td>
<td>6.27</td>
<td>1.22</td>
<td>2.05</td>
<td>244,252</td>
</tr>
<tr>
<td>City, Cedar Rapids</td>
<td>4th Ave Parkade</td>
<td>335,626</td>
<td>Open Air Parking Ramp</td>
<td>7.55</td>
<td>6.27</td>
<td>1.20</td>
<td>2.08</td>
<td>430,632</td>
</tr>
<tr>
<td>City, Cedar Rapids</td>
<td>Ellis Parks Maint.Bldg</td>
<td>4,542</td>
<td>Maintenance Repair</td>
<td>111.95</td>
<td>95.21</td>
<td>1.18</td>
<td>2.13</td>
<td>76,019</td>
</tr>
<tr>
<td>City, Cedar Rapids</td>
<td>Fire Station #8</td>
<td>2,806</td>
<td>Fire Station</td>
<td>102.54</td>
<td>89.56</td>
<td>1.14</td>
<td>2.18</td>
<td>36,421</td>
</tr>
<tr>
<td>City, Cedar Rapids</td>
<td>Fire Station #5</td>
<td>4,387</td>
<td>Fire Station</td>
<td>93.60</td>
<td>87.06</td>
<td>1.08</td>
<td>2.33</td>
<td>28,680</td>
</tr>
<tr>
<td>City, Cedar Rapids</td>
<td>Public Works Facility</td>
<td>367,000</td>
<td>Warehouse - Active</td>
<td>64.37</td>
<td>69.73</td>
<td>0.92</td>
<td>2.71</td>
<td>0</td>
</tr>
<tr>
<td>City, Cedar Rapids</td>
<td>Fire Station #2</td>
<td>3,425</td>
<td>Fire Station</td>
<td>80.52</td>
<td>88.70</td>
<td>0.91</td>
<td>2.75</td>
<td>0</td>
</tr>
</tbody>
</table>
3.6.2. **Determine Buildings with the Most Potential in Energy Savings**

Buildings with the highest potential for energy savings are buildings with a high B3 Benchmark ratio (above 1.0) and a large building square footage. They can be easily compared by looking at the “Potential Savings” column in the table.

3.6.3. **Calculate the Potential Energy Savings**

The potential energy savings column in Table 6 is calculated by (“Actual EUI” – “Benchmark EUI”) x “Current SF” for buildings with B3 Benchmarking ratio > 1.0. For buildings with B3 Benchmarking ratio < 1.0, the organization still can set a targeted EUI that is lower than the B3 Benchmark EUI and calculate potential energy savings by themselves. For example, if the City Hall in the city of Bondurant wants to reduce the EUI from the current actual EUI of 72.79 kBu/SF/Year to targeted 50.00 kBtu/SF/year, the potential energy savings could be (72.79-50.00) x 4,275 = 97,428 kBtu/Year.

3.7. **Sample B3 Benchmarking Data Statistics by Utility**

Utilities can benefit from the B3 Benchmarking system by finding out the sites with the bad energy performance under their service territory, and plan energy efficiency projects focusing on those buildings first. A sample B3 Benchmarking statistics by utility combination is shown as an example in this section.

3.7.1. **Basic Data Statistics**

A sample data statistics table is shown in Table 7. This table shows the building energy related statistics for public buildings sorted by utility. Statistics in the table include utility name, organization name and sector, site name, current space area in square feet, actual energy use intensity (EUI) in kBtu/SF/Year, benchmark EUI in kBtu/SF/Year, B3 energy benchmarking ratio, and potential energy savings in kBtu (if can reduce the buildings that have EUI > 1.0 to EUI = 1.0) for that site.

All benchmarking statistics by utility are listed as a separate document entitled “Building Energy Benchmarking Pilot Project Results”.

3.7.2. **Determine Buildings with the Most Potential in Energy Savings**

For a specific utility, the buildings with the most potential in energy savings are the buildings with the higher B3 Benchmarking ratio and large building square footage. They can be easily compared by looking at the “Potential Savings” column in the table for a specific utility. However, for a single site, the potential of energy savings may not be fully contributed by this utility if all energy sources are not provided by the same utility.
Table 7. Sample B3 Benchmarking Statistics by Utility

<table>
<thead>
<tr>
<th>Utility Name</th>
<th>Organization Name</th>
<th>Site Name</th>
<th>Current SF</th>
<th>Actual kBtu/SF/Yr</th>
<th>Benchmark kBtu/SF/Yr</th>
<th>Benchmarking Ratio</th>
<th>Potential Savings kBtu/Yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriland FS</td>
<td>State, Transportation</td>
<td>Adair East Bound Rest Area Site</td>
<td>5,116</td>
<td>126.59</td>
<td>94.50</td>
<td>1.34</td>
<td>164,169</td>
</tr>
<tr>
<td>Agriland FS</td>
<td>State, Transportation</td>
<td>Chariton Maint Garage Site</td>
<td>21,639</td>
<td>8.79</td>
<td>35.84</td>
<td>0.25</td>
<td>0</td>
</tr>
<tr>
<td>Agriland FS</td>
<td>State, Transportation</td>
<td>Lamoni Rest Area Site</td>
<td>6,804</td>
<td>1.71</td>
<td>104.71</td>
<td>0.02</td>
<td>0</td>
</tr>
<tr>
<td>Agriland FS</td>
<td>State, Transportation</td>
<td>New Oskaloosa Maint Garage Site</td>
<td>31,832</td>
<td>24.01</td>
<td>0.00</td>
<td>0.00</td>
<td>0</td>
</tr>
<tr>
<td>AgVantage FS</td>
<td>State, Transportation</td>
<td>Tiffin East Bound Rest Site</td>
<td>5,166</td>
<td>156.19</td>
<td>97.48</td>
<td>1.60</td>
<td>303,282</td>
</tr>
<tr>
<td>AgVantage FS</td>
<td>State, Transportation</td>
<td>Tiffin West Bound Rest Site</td>
<td>1,588</td>
<td>51.67</td>
<td>85.32</td>
<td>0.61</td>
<td>0</td>
</tr>
<tr>
<td>Algona Municipal Utilities</td>
<td>Community Colleges, IA</td>
<td>Algona Campus</td>
<td>18,800</td>
<td>75.22</td>
<td>81.53</td>
<td>0.92</td>
<td>0</td>
</tr>
<tr>
<td>Algona Municipal Utilities</td>
<td>State, Public Defense</td>
<td>Algona Armory</td>
<td>20,418</td>
<td>47.04</td>
<td>76.37</td>
<td>0.62</td>
<td>0</td>
</tr>
<tr>
<td>Algona Municipal Utilities</td>
<td>State, Transportation</td>
<td>Algona Maint Garage Site</td>
<td>22,685</td>
<td>32.62</td>
<td>39.85</td>
<td>0.82</td>
<td>0</td>
</tr>
<tr>
<td>Allamakee Clayton Electric Cooperative, Inc.</td>
<td>State, Transportation</td>
<td>Waukon Maint Garage Site</td>
<td>14,974</td>
<td>65.08</td>
<td>36.17</td>
<td>1.80</td>
<td>432,915</td>
</tr>
<tr>
<td>Alliant Energy - IPL</td>
<td>City, Cedar Rapids</td>
<td>3rd Ave Parkade</td>
<td>212,436</td>
<td>5.60</td>
<td>6.27</td>
<td>0.89</td>
<td>0</td>
</tr>
<tr>
<td>Alliant Energy - IPL</td>
<td>City, Cedar Rapids</td>
<td>4th Ave Parkade</td>
<td>335,626</td>
<td>7.55</td>
<td>6.27</td>
<td>1.20</td>
<td>430,632</td>
</tr>
<tr>
<td>Alliant Energy - IPL</td>
<td>City, Cedar Rapids</td>
<td>5 Seasons Parkade</td>
<td>358,174</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0</td>
</tr>
<tr>
<td>Alliant Energy - IPL</td>
<td>City, Cedar Rapids</td>
<td>Bever Park Office/Maint.</td>
<td>12,741</td>
<td>30.01</td>
<td>90.90</td>
<td>0.33</td>
<td>0</td>
</tr>
<tr>
<td>Alliant Energy - IPL</td>
<td>City, Cedar Rapids</td>
<td>Ellis Golf Club House</td>
<td>3,098</td>
<td>103.11</td>
<td>116.36</td>
<td>0.89</td>
<td>0</td>
</tr>
<tr>
<td>Alliant Energy - IPL</td>
<td>City, Cedar Rapids</td>
<td>Ellis Parks Maint.Bldg</td>
<td>4,542</td>
<td>111.95</td>
<td>95.21</td>
<td>1.18</td>
<td>76,019</td>
</tr>
<tr>
<td>Alliant Energy - IPL</td>
<td>City, Cedar Rapids</td>
<td>Fire Station #2</td>
<td>3,425</td>
<td>80.52</td>
<td>88.70</td>
<td>0.91</td>
<td>0</td>
</tr>
<tr>
<td>Alliant Energy - IPL</td>
<td>City, Cedar Rapids</td>
<td>Fire Station #3</td>
<td>4,801</td>
<td>74.39</td>
<td>88.24</td>
<td>0.84</td>
<td>0</td>
</tr>
</tbody>
</table>
4. LESSONS LEARNED AND RECOMMENDATIONS

There were many challenges and lessons learned during the pilot project implementation process. This chapter summarizes the challenges and recommendations for improvements going forward.

4.1. Finding the Right Organizational Contact

After the organization made the executive decision to participate in the pilot project, finding the right contact person (data owner) with knowledge of both buildings and associated utility meter accounts was sometimes difficult. To find the correct contact requires persistence and experience of the benchmarking sector leaders to ask the correct questions in order to find the best contact person inside the organization. In some cases an organization may not have just one person that is qualified to provide all the information required.

Recommendations:

Although a description of what information would be required from each organization was listed in the initial invitation to participate, a more real-life example may provide better clarity in helping the organization know who or what team would be best to interface with the information requirements of the benchmarking effort.

For initial project set-up, a benchmarking organization contact manager or sector leader providing hands on assistance is essential for finding the correct organizational contact. Better communications within the organization regarding the project and organization contact responsibilities would also help in the later process.

4.2. Associating Building Data with Utility Accounts and Meters

Accurate benchmarking results require the correct association of building sites with the utility account meters that serve the building site. A building template spreadsheet was sent to each organization contact to enter required data about their buildings and to map meter account information to the building. This is a standard template that once filled out is then imported into the B3 Benchmarking database.

The challenges associated with entering building template data include: Incompleteness of template data received, especially with organizations that had 20+ buildings; incorrect information due to human error, or not knowing where to find the correct information. The department responsible for building facility data was not always the department that received the utility bills (Public Works versus Finance). Accurate data had to be gathered from multiple sources within an organization; Multi-purpose buildings require percent breakdown of the space types within the building and were a challenge to fill out data accurately.
Recommendations:

Attendance of the organization contact(s) in a training webinar prior to filling out the Building Template information is essential. Organizations should send one copy of one monthly utility invoice for all building sites to the Benchmarking sector leader, to allow the sector leader to verify information entered in the building template prior to template import. Typically a list of buildings mapped to meter accounts does not exist, either within the organization or the utility, and needs to be developed for initial project set up. For organizations that have many buildings this can be the most time consuming initial benchmarking set-up task, but once completed accurately, requires little follow up work.

4.3. Establishing and Signing Utility Authorization Forms

Based on the information collected from the building template, utility authorization forms were manually created and sent to the organization contact for signature. The authorization forms grant permission from the organization to the utility to provide energy and cost data to the Iowa Energy Center to upload data into the Benchmarking program. Then the signed authorization forms are returned to the Center and signed by the principal investigator. Lastly, the authorization forms are sent to the utility requesting meter consumption and costs data.

During the pilot project the process for developing the correct authorization language, data, and format acceptable to all utilities, then creating the forms, and having them signed by all representatives, and storing them from multiple emails exchanges, clearly consumed the most effort of implementing the pilot Benchmarking project. The process is labor intensive and requires significant communication time to coordinate the owner, the utility, and the Benchmarking administration staff to identify the correct meters and accounts authorized for the release of meter consumption data. A sample authorization form is illustrated in the Appendix C.

Recommendations:

Going forward it is suggested an online method is developed for generating an authorization request, verifying account numbers with the owner and utility company, signing, and tracking status of when authorization forms are approved and archived.

4.4. Obtaining Utility Data and Import to B3 Benchmarking System

All utility contacts were very cooperative during the entire data collection process. There were, however, some problems and challenges in collecting the utility data and importing information into the Benchmarking platform. Some errors occurred by matching customer identified account and meter numbers to utility accounts and meter numbers. Account and meter numbers are typically long alpha/numeric data strings that can be easily entered
incorrectly. Some utilities provided data by calendar month versus start and end date of actual reading. Some data that came from the utilities did not match the records for an organization because the utility estimated the usage rather than readings from the meter – causing inaccuracy of monthly energy data. There are still rare cases where some utilities provided data by hand writing account and consumption data and faxing data to be hand entered. Utilities provided varying format templates of historic data readings, which required developing different import routines into the application.

Recommendations:

A standard process by the utilities to collect historic and on-going energy consumption data on meter and account numbers that have been authorized to be entered into the Benchmarking program is highly recommended. It is envisioned that there will be two or three process solutions to cover the range of billing and archival system capabilities for various utilities. On the high technology solution side a web-service connection protocol where consumption data from a utility would automatically be imported into the Benchmarking application is highly desirable. On the low technology side the Benchmarking team could receive faxed invoices from the utility or the organization through a fax server and enter data directly by hand into the Benchmarking application.

4.5. Verifying Data

Data verification is another step to make sure the validity of the energy benchmarking of each building/site. Effective communications with the utilities and the organizations is the key. Below is a list of quality assurance steps learned and developed during the pilot benchmarking process to minimize potential errors:

- Assist organizations in defining correct space/building type for their building(s).
- Verify that account or meter number supplied by the organization matches valid utility meter and account numbers. If match does not occur communicate with the organization for verification.
- Verify that all organizations account numbers match the account numbers on the authorization forms.
- For buildings with less than 12 months of consumption data, review with organization if it is due to new construction or remodeling purposes.
- For building sites with extremely high or low benchmark ratios contact the organization to verify building floor area is correct, building space usage type has been accurately defined, correct meters are attached, and correct consumption units have been selected in the meter editor.

4.6. Sub-Meter Issues

Many of the State and Community College sector buildings are campuses that have building and meter relationships that do not provide the ability to measure all fuel sources for
a single building separately. For these cases Benchmarks can only be compared for a group of buildings served by the set of meters isolated to those buildings. This information is useful but cannot identify which building(s) in the site group are performing higher or lower than expected. This condition is typical for campus systems where a few utility revenue meters serve the entire campus and only some of the buildings are sub metered.

Recommendations:

Campus style facilities should make plans to add additional sub-meters in the future to isolate the performance measurement to separate buildings on their campuses.

4.7. Benchmarking Management Staffing

The information required to do building benchmarking resides in two separate silos. Organizations have the facility information, and the utilities have the consumption information, and it is the Benchmarking management’s staff’s job to connect these two information silos into one knowledge system. We have learned that an effective benchmarking program requires consistent management of the human network to ensure all the data is accurately gathered and updated.

During the start of the pilot phase, IEC hired four Iowa State student interns to be sector leaders, providing outreach, data acquisition assistance, and troubleshooting, to various public building organizations. After the first 10 months of the project two interns had resigned or stopped working on the project, and a third resigned prior to our last three months of data analysis and troubleshooting.

Recommendations:

It is recommended that the Benchmarking management team be staffed by long term employees in the future to maintain program relationships, communications, and institutional knowledge. Students should be included in building science research related to the database for increasing capacity in energy research within Iowa, but full-time staffs are required for effective management and communication.
5. LONG TERM BENCHMARKING PROJECT BENEFITS AND RECOMMENDATIONS FOR CONTINUING THE PROGRAM

5.1. Long Term Benchmarking Project Benefits

A State-wide public building benchmarking program that collects and maintains both physical building attributes and on-going energy consumption for a large population of public buildings will improve the knowledge for a broad range of stakeholders to reduce improvement first costs for saving energy and make better technology decisions over time. In November of 2011, a roundtable convened by the Iowa Energy Center of national, regional and local experts in building energy efficiency including utility program managers to identify strategic projects and research. All participants agreed that a state building benchmarking program could provide immediate and long term opportunities from energy resource planning, to reducing energy expenditures inside the State of Iowa.

Long term building energy benchmarking benefits include:

- Improving financial performance by reducing upfront retrofit expenditures or increasing annual energy savings by finding high ROI projects for public organizations, state operated or utility operated energy improvement programs.
- Improving operational management practices for public building owners and stakeholders through operational education and knowledge to improve energy performance through on-going awareness and better management practices. You can’t manage what you don’t measure.
- Improving knowledge of applicable technologies through a regional research database of technology retrofits and actual energy savings.
- Measurement of energy consumption before and after a retrofit improvement is implemented to verify actual savings.
- Providing data for on-going building science research.
- Serving as a planning tool for the State, utilities and public building organizations.

5.1.1. Improving Financial Performance

Building retrofit improvement programs can reduce the first cost retrofit investment by 25 to 50 percent using a benchmarking system to screen and select high ROI projects as compared to a random or volunteer selection process (Greden 2008). Benchmarking provides a quick assessment to determine if a buildings actual energy consumption is more or less than expected. Buildings using less energy than expected may have fewer opportunities to save energy and will mostly require a higher expenditure of dollars to achieve the same savings potential as a building using more energy than expected. A benchmarking program can easily sort and rank which buildings are using more energy than expected, providing a higher return on investment. A higher return on investment means less investment risk, by returning a faster payback, and public improvement dollars can be stretched to serve more projects and constituents.
To illustrate the financial benefit of operating a benchmarking program to qualify projects for an improvement program, a hypothetical example is developed. Based on the current portfolio of 1,218 buildings, two different methods are used to select 200 building sites to improve, and then the potential annual energy use and cost savings for each selection method are compared.

The first method is a targeted benchmark approach using the knowledge obtained from the current benchmarking program to select the top 200 building sites that had the highest energy savings potential within the portfolio. The second method is a random approach using a random number generation selection algorithm. In both selection cases the same method was used to calculate the potential energy savings for a building site selected. The technical potential savings was measured by subtracting the Actual EUI from the Benchmark Code EUI then multiplied by building area. Table 8 compares the results of the potential improvement in annual savings between the two selection methods used.

Table 8. Potential Annual Energy Savings Benefit Using a Targeted Benchmark Approach

<table>
<thead>
<tr>
<th>Improvement Characteristics</th>
<th>Targeted Benchmark approach</th>
<th>Random approach</th>
<th>Targeted Benchmark approach savings benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Building Sites</td>
<td>200</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>Floor Area (SF)</td>
<td>11,826,348</td>
<td>11,968,125</td>
<td></td>
</tr>
<tr>
<td>Annual Energy Savings Potential (kBTU)</td>
<td>301,068,030</td>
<td>133,004,076</td>
<td><strong>168,063,954</strong></td>
</tr>
<tr>
<td>Annual Estimated Energy Cost Savings (US $)</td>
<td>$3,913,884</td>
<td>$1,729,053</td>
<td><strong>$2,184,831</strong></td>
</tr>
</tbody>
</table>

This hypothetical study using a targeted benchmarking portfolio approach to select buildings to improve could result in 2 million dollars in additional annual savings as compared to selecting and improving buildings on a random base. Assuming the annual cost of maintaining and operating a benchmarking system is $250,000 per year for a portfolio of this size, the benefit is over 8 times the cost just by using the benchmarking program to intelligently target the buildings with the most potential in energy savings.
5.1.2. Improving Operational Management

Providing a web portal benchmarking program for public building owners and stakeholders to view up-to-date energy performance of their building portfolio’s energy performance will improve decision making and management practices. As economist John Kenneth Galbraith once said, “things that are measured tend to improve”, a web-portal benchmarking system will allow enterprise viewing and updating of energy performance results using easy to understand rankings to determine which buildings are using more or less energy than expected to how a building compares to its past historic consumption trends. The benchmarking program could also be set up to provide challenge competitions that reward and recognize organizations that track and reduce their energy consumption to create a market for others to follow. Institutionalized awareness and knowledge will provide for more accountable energy management oversight, resulting in improved performance at lower costs.

5.1.3. Improving Knowledge Base through a Regional Database

A benchmarking program connects various building attributes to actual energy consumption trends to provide a comprehensive regional building energy database that could be used for a variety of research initiatives to reduce the energy consumption in the state. The data base could be used to assist in developing technical energy savings potential studies, new energy efficiency program design, technology assessment studies, and energy improvement program budgeting, to name a few.

5.1.4. Serving as a Measurement Verification Tool

An important feedback loop for implementing any building improvement is to measure and verify if the actual improvement savings is closely matching the expected savings estimates. A good measurement and verification protocol then reports back the performance to all stakeholders to identify if any corrective actions are required and to inform the need if any for future process improvements. An on-going benchmarking program can automatically provide this level of measurement and verification; allowing users to easily review the actual consumption reductions before and after improvements are made. Generally, financing authorities of energy improvement programs have higher confidence in projects or programs that have a well-planned measurement and verification process in place to reduce risk. The benchmarking program can be used for tracking various energy efficient improvement programs operated by utilities, state, or performance contracting groups.

5.1.5. Providing Data for On-going Building Energy Research

A Benchmarking system provides basic building energy data for Iowa-specific buildings and is suitable for on-going building energy related research. Researchers can use the Iowa specific data to find out why some buildings are more energy efficient than
others by accessing the database of building characteristics and energy consumption to suggest future improvements in energy efficient measures. Research can also be conducted in the areas of state energy policy and for developing financial assistance budgets for energy efficiency projects.

5.1.6. Serving as a Planning Tool

Besides the above mentioned long term benefits, more important than just understanding the technical savings potential, the Benchmarking program can identify specific buildings for improvement. Instead of randomly selecting projects for energy audits and improvement programs where high performing buildings will be as likely studied as low performing buildings, the Benchmarking program can become a screening and feeder management tool for energy efficiency programs. It is estimated that the sample size of the current benchmarking database represents less than 20% of the entire portfolio of public buildings in the state, and if true and if this sample is representative of the remaining buildings, the savings potential in the state would be 5 times greater.

Currently the State of Minnesota is using the B3 Benchmarking program to qualify projects for the Public Buildings Enhanced Energy Efficiency Program (PBEEEP) for State and Local Governments. Projects with actual energy consumption higher than their expected benchmark can secure technical and financial assistance to perform energy audits for re-commissioning and retrofit improvement projects. After the improvement projects are completed, the B3 Benchmarking program is used to conduct measurement and verification studies using the programs weather normalized target comparison to determine actual savings.

5.2. Recommendations for Continuing the Program

Because of the long term benefits of the Iowa building benchmarking project mentioned above, it is highly recommended that the project continues for long term. The pilot project provides a very good start and created an initial Iowa-specific building energy benchmarking database. The organizations that are already enrolled into the system should be able to continue using the platform monitoring their building energy use and do their energy efficient planning accordingly. Ideally, the database could be expanded to include more public buildings in Iowa.

Since the pilot project is funded by a one-time funding from the Department of Energy and cost shared by the Iowa Energy Center, a more stable funding source is needed in the future for the continuation of the Iowa benchmarking project. Future project cost can be shared among organizations that participate in the project as well as utilities who service these buildings, as part of the program of their 5 year energy efficiency plan.
5.2.1. Future Project Scope of Work and Cost

There are two future project options: a) maintain the existing database, and b) expand existing database to include more organizations/buildings (public or private) at a rate of 800 buildings per year.

For option a):

Scope of work:

- Project management;
- Maintain relationship with all organizations and discuss any future problems regarding building and energy data;
- Conduct 12 monthly training webinars for organization participants;
- Conduct 12 monthly internal management/status meetings;
- Conduct 4 quarterly stakeholder advisory meetings;
- Custom software feature/reporting enhancements based on 20k budget allowance;
- Use of the B3 Benchmarking system supporting website, user application, control center application, data exports, daily project back-ups and data caches, and real-time climate variables updates to maintain weather normalization comparisons in the 3 Iowa climate zones;;
- Incorporate new program features defined on the B3 product development roadmap;

The estimated total cost for option a) is $180,000/year, including:

- Benchmarking project manager’s time;
- Benchmarking staff’s time;
- B3 Benchmarking License Fee;

The estimated total cost above does not include a method for on-going import of monthly energy consumption data from utility companies for the existing sites in the current database. One solution for on-going energy consumption updating is for existing organizations to enter monthly consumption and cost data from utility invoices using the meter editor in the B3 Benchmarking application.

For option b):

Scope of work:

- Project management;
- Contact new organizations to get new building information. Maintain relationship with all organizations, and discuss any future problems regarding building and energy data;
- Conduct 12 monthly training webinars for organization participants;
- Conduct 12 monthly campaign management/status meetings;
• Conduct 4 quarterly stakeholder advisory meetings;
• Custom software feature/ reporting enhancements based on 20k budget allowance;
• Use of the B3 Benchmarking system supporting website, user application control center application;
• Incorporate new program features defined on the B3 product development roadmap;
• Develop using web-based data acquisition protocol with Iowa utilities so energy data can be automatically retrieved and stored in B3 Benchmarking database;
• Add 800 new buildings in the database.

The estimated total cost for option b) is $250,000/year, including:

• Project manager’s time;
• Benchmarking staff;
• B3 Benchmarking License Fee;
• Develop on-going energy consumption data acquisition protocols with Iowa utilities (web-based and manual methods);
• Add 800 new buildings in the database.

The estimated total cost above does not include a method for on-going import of monthly energy consumption data from utility companies for the existing sites in the current database. One solution for on-going energy consumption updating is for existing organizations to enter monthly consumption and cost data from utility invoices using the meter editor in the B3 Benchmarking application.

5.2.2. Future Project Structure

It is recommended that the future team structure will remain similar to the project structure for the pilot project except using long term employees instead of student interns as sector leaders to maintain the continuity of the team and relationships with the organizations. As a research-based and unbiased non-profit organization, Iowa Energy Center can serve as the leading organization for this project, serving its mission of providing energy efficiency information and education to Iowans.

5.2.3. Integrating Benchmarking Platform into Building Energy Improvements

The Benchmarking team will work very closely with the state agencies, utility regulators, and utilities providing information and helping them with energy efficient planning and implementation. This pilot project is one of the key steps to identify building problems and serve as measurement and verification tool for energy efficiency measures. Integrating the Iowa Building Energy Benchmarking platform into the process cycle of planning, financing, implementing, and validating energy efficiency programs and projects in the state of Iowa is highly recommended as one of many next steps for the meeting the long term goals of reducing energy use and conservation of energy in the state of Iowa. Figure 12 shows the recommended building energy improvement process model for existing buildings.
Figure 12. Building Energy Improvement Process Model
6. CONCLUSIONS

Iowa has made significant strides in gaining energy efficiency in the past, and the Iowa Public Building Benchmarking is another step forward to get it to another level. An energy benchmarking program will be more cost-effective at targeting high ROI building candidates than selecting projects at random or by invitation. An on-going long-term benchmarking program can provide insightful post improvement measurement and verification that will help ensure savings goals are maintained and sustained. Moreover, without a benchmarking tool, it is difficult to determine if a given building is using more or less energy than expected as compared to a similar building designed in accordance with the current Iowa energy code. The benchmarking program will help entities understand how their respective buildings consume energy in comparison to their peers, and drive further savings by awareness and social behavior.

Despite many challenges, the Iowa Public Building Benchmarking Pilot Project has successfully tracked and analyzed over 1200 public buildings in the State of Iowa, and has created momentum for doing so with over 53 organizations and 49 utilities participating. The data and knowledge gained from the benchmarking pilot project can assist state and utility energy efficiency programs today to intelligently target projects that will save more energy and have a higher return on investment than current methods in place.

The selected B3 Benchmarking platform can benchmark buildings using multiple criteria and is especially suitable for state-wide benchmarking projects. Data statistics shows that there is approximately 36% of the total square footage area in the 1200+ buildings surveyed are not energy code compliant. This means there is still a lot to be done in the area of building energy efficiency for public buildings in Iowa. On-going support (including financial support) to maintain the current momentum and adding organizations to the benchmarking system will provide a significant benefit at many more times its cost to reducing the annual energy consumption of public buildings in the state. Streamlining the building energy efficiency improvement process by integrating the Iowa Benchmarking platform into the planning, financing, implementation and validating cycle to provide a targeted approach is highly desirable.
REFERENCES

APPENDICES

Appendix A. B3 Benchmarking System Sample Screen Shots at Site Level

Sample screen shots at Site level are given in this appendix to show basic capabilities of the B3 Benchmarking system.

Figure A1. Summary Tab (Site)
**Figure A2. Benchmark Tab (Site)**
Figure A3. Peer Comparison Tab (Site)
Figure A4. ENERGY STAR Tab (Site)
Figure A5. Baseline Tab (Site)

Figure A6. Target Tab (Site)
Figure A7. Target Editor 1

Figure A8. Target Editor 2
Figure A9. Target Editor 3

Figure A10. Target Editor 4
Appendix B. B3 Benchmarking System Report Options

Currently there are nine options in the B3 Benchmarking platform in generating reports.

1. **Total Energy Dashboard**: monthly electric and natural gas consumption in kBtu/SF vs. baseline numbers displayed in a graphical format;
2. **Electric Monthly Continuous**: monthly electric consumption in kWh vs. baseline numbers displayed in a graphical format;
3. **Natural Gas Monthly Continuous**: monthly natural gas consumption in kBtu vs. baseline numbers displayed in a graphical format;
4. **Electric Year Over Year By Month**: monthly electric consumption in kWh displayed in a year-over-year curve graphical format;
5. **Natural Gas Year Over Year By Month**: monthly natural gas consumption in kBtu displayed in a year-over-year curve graphical format;
6. **Annual Fuel Consumption**: annual fuel consumption in kBtu displayed in a bar chart format;
7. **Annual Fuel Consumption (CO2)**: annual CO2 emission in Metric Ton displayed in a bar chart format;
8. **Rolling 12 Month Average**: monthly electric and natural gas consumption in kBtu displayed in a rolling 12-month average curve;
9. **Target**: monthly electric and natural gas consumption in kBtu as compared with the customized “target” set.

Below are sample screen shots for these report options (for Option 1 Total Energy Dashboard please refers to Figure 11 in the main text.)
Figure B1. Reports Tab: Electric Monthly Continuous

Figure B2. Reports Tab: Natural Gas Monthly Continuous
Figure B3. Reports Tab: Electric Year Over Year By Month

Figure B4. Reports Tab: Natural Gas Year Over Year By Month
Figure B5. Reports Tab: Annual Fuel Consumption

Figure B6. Reports Tab: Annual Fuel Consumption (CO2)
Figure B7. Reports Tab: Rolling 12 Month Average

Figure B8. Reports Tab: Options
### Figure B9. Reports Tab: Target

#### Monthly Continuous
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<th>Change from Target kWh</th>
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Appendix C. A Sample Authorization Form

Authorization for Third Party Release of Information

To authorize a Third Party to receive information regarding the following utility account, please complete the form below and return it via Fax 515-294-9912 to the Iowa Energy Center at Iowa State University; or via email to Kathleen Harrison or by scanning and uploading to the www.ia33kennethcimino.com website. The Iowa Energy Center (Third party) at Iowa State University will sign and forward to the corresponding utility. This request will not be accepted by the utilities without the signature of both the customer and third party.

Customer/Organization __________________________

Address ____________________________________________

City __________________ State ___________ Zip __________

Phone Number __________________________

Account Number __________________________

Address of Account, if different from above:

Address ____________________________________________

City __________________ State ___________ Zip __________

MidAmerican Energy Company __________________________ has my permission to share my organization’s (insert utility name here) account information with the Third Party named below for use in the building energy benchmarking pilot project conducted in Iowa, and I am authorized to provide this release for the organization.

Customer Signature __________________________

Date __________________

Name of Third Party to Receive Information

Third Party Name __________________________

Mailing Address __________________________________________

City __________________ State ___________ Zip __________

Phone __________________ Fax __________________

Third Party Signature __________________________

Date __________________

June 30, 2011

Figure C1. A Sample Authorization Form